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Tools for Creating Custom Physical Computer Interfaces

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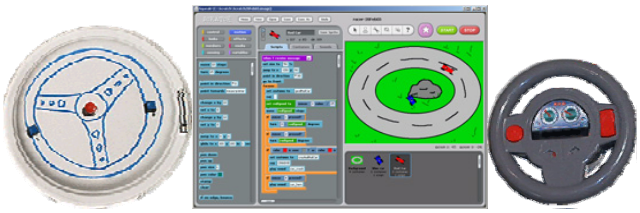
ABSTRACT
The Hook-ups project introduces a new set of tools and activities intended to support children in creating physical computer input devices for computer programs they write. This project introduces a new approach to learning through design by providing opportunities for children to engage in both the physical and computational design concurrently. This demonstration proposal describes three types of Hook-ups (basic, repurposed, and fabricated) and introduces a set of puzzle piece-based building blocks called Scratch Patches that youth can connect to construct physical input devices. In this demonstration session, participants will have the opportunity to interact with existing Hook-ups interfaces, including several designed by youth, and construct their own Hook-ups.

Keywords
Interface design, tangible interfaces, programming, education

INTRODUCTION
There is growing interest in combining physical and computational design activities for youth [1]. In 2003, Eisenberg challenged designers to blend physical and virtual activities to improve the types of computer-enhanced educational experiences envisioned by Papert in the 1980s [2] and suggested several strategies for doing so [3]. The Hook-ups project offers a new approach to combining computation and physical materials by providing tools and activities for youth to create physical computer input devices, and learn about design in the process.

Recent research shows benefits of combining physical and virtual design [4]. Design activities that combine physical and computational design offer opportunities for youth to be creative, learn new concepts, and express themselves. Learners creating Hook-ups stand to gain hands-on understandings of concepts in feedback and control while further developing their understanding of the design process.

OVERVIEW OF HOOK-UPS
Hook-ups are physical objects youth make to control games, animations, and other computer programs they create. In making Hook-ups, youth work with materials ranging from everyday objects to output from personal fabrication devices such as laser cutters. For example, children could construct steering wheels to control cars in a driving game that they've programmed. Each creation process includes integrating some combination of the following elements: sensors, physical materials to which sensors attach, sensor-querying computer interface boards, and sensor-input-ready programming environments. The following paragraphs illustrate three types of Hook-ups - each of which connect to a new programming environment called Scratch [5].



Basic Types of Hook-ups
Basic Hook-ups are everyday objects with pre-packaged sensors attached to them. They connect to Scratch through pre-made Scratch-ready Hook-up boards. In making a "basic," a learner could draw a steering wheel on an unused paper plate, tape pushbuttons on the drawing, plug the button's wires into a Hook-up interface board, and write a program that moves an animated car around the screen in different ways for each button.

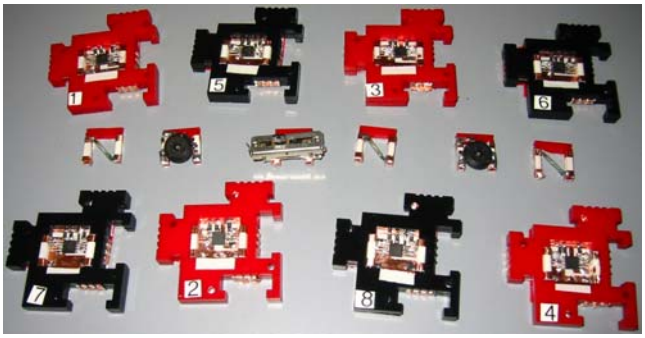
Repurposed Types of Hook-ups
Repurposed Hook-ups are electronic objects that were previously used to control existing consumer electronics (e.g., a model car remote control). A "repurposed" results from learners discovering ways to redirect existing controls of a product to Scratch. A learner could make a "repurposed" to control a virtual car by taking apart a toy steering wheel and redirecting its buttons to a Scratch program.

Fabricated Types of Hook-ups
A fabricated Hook-up is an input device for which many of the parts were designed and built by the learner. The availability of personal fabrication tools such as laser cutters, vinyl cutters, and desktop mills are integral to their

creation. Fabrication tools, activities and materials give learners the ability to design objects such as sensors, circuits, and casings using a variety of stock materials. A learner could fabricate a steering wheel by drawing one on a computer, laser cutting it from a piece of plastic, placing buttons on the print-out, and adding a home-made circuit board to the structure that connects the model steering wheel to Scratch.

SCRATCH PATCHES

To help facilitate fluid movement between physical and computational design, we are developing Scratch Patches – puzzle piece-based building blocks youth connect to construct physical input devices. Scratch Patches provide learners with simple components with which they can build complex input devices. The most complex devices can currently support up to 16 sensors; however, any learner with ambition and access to fabrication tools can extend the current set of patches or design their own.

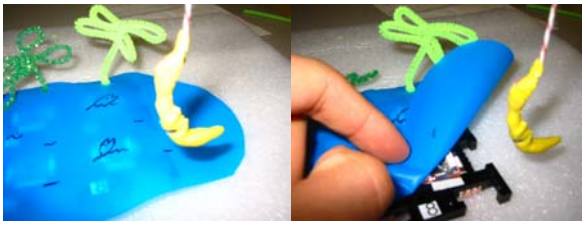


Three Types of Scratch Patches

Three types of Scratch Patches combine to form a highly customizable input device. A communicator patch (C-patch) sends Scratch programs real-time sensor information it receives from patches attached to it. C-patches connect to computer serial ports, power supplies, and other patches. A sensor patch (S-patch) can hold several types of sensors that measure one aspect of the physical world (such as light) and translate the measurements for Scratch. Each S-patch can hold up to 2 sensors in three different ways: pressed into a "sensor-socket," soldered to copper contacts, or held in a slot for wires. An extender patch (E-patch) relays power and data to other patches. E-patches change the size and shape of a Scratch Patch input device. To further change the look and feel of Scratch Patch input devices, each patch surface has places where one can secure craft materials or patch layers.

Sample Scratch Patch Activity: Interactive Fishing

In making an interactive fishing application, a learner could arrange and decorate Scratch Patches in configurations that resemble lakes. They could use materials nearby to make magnetic model fishing poles and decorate patch surfaces. Dangling magnets over patches that hold magnetic sensors could then trigger virtual fish to be caught in a Scratch program.



DESIGN STRATEGIES

In creating Hook-ups, youth have learned useful design strategies. For example, Three Hook-ups builders learned to use materials in unexpected ways. In making fishing poles, a learner rejected the notion they found in a tutorial that suggested that fishing was moving a magnet over stationary sensors. Instead, he fished for stationary magnets with moving magnetic sensors. Instead of using scissors to cut, one child used them as a detonator for on-screen explosions by taping two wires to where the scissor handles meet (thus creating a scissor-switch interface). Another child used magnets as building blocks to construct "prosthetic legs" for a broken fabricated-puppet for which he and his peers were programming interactive animations.

DEMONSTRATION DESCRIPTION

In this demonstration, conference participants will interact with existing Hook-ups interfaces, including several designed by youth, and construct their own Hook-ups.

ACKNOWLEDGMENTS

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